

The fisheries of Africa: Exploitation, policy, and maritime security trends

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ABSTRACT

African maritime countries take the majority of their animal protein from fish. Bound with tradition and a promise of food and other values, African fisheries also provide a source of livelihood for over 35 million coastal fishers. Yet, as in many other regions of the world, the fishing sector is plagued with policy failures, and illegal activities. This paper summarizes the key points in the evolution of African fisheries in terms of exploitation, policy, and maritime security trends. It addresses how access to fishing by the small-scale sector is increasingly hindered by the increasing power and scope of an industrial fleet often involved in Illegal, Unreported, and Unregulated (IUU) fishing. It also discusses the impacts of ineffective enforcement against overexploitation and illegal fishing, piracy, human smuggling and climate-change risks for coastal communities, as well as policy measures and initiatives to reverse the existing trends.

1. Introduction

African waters are known for the abundance of their fishery resources. Three of the six Large Marine Ecosystems (LMEs) of Africa rank within the first four most productive LMEs in the world, with the Canary Current, the Benguela Current and the Somali Coastal current ranking 2nd, 3rd and 4th globally [96]. Not surprisingly, the fisheries of Africa provide a source of livelihood for 35 million¹ active fishers and their families [25,110]. If all catches were landed in Africa, African fisheries could contribute a landed value of \$20 billion US\$ to national economies [www.seaaroundus.org] – with foreign fishing, discards, and illegal fishing all included, with an additional \$3.6 billion generated across the value chain by the small-scale fishing sector alone ([45]; see also De Graff and Garibali [41]).

Despite this importance, fisheries in Africa are often plagued with issues such as under-reporting, where an estimated 46% of fish catches are never reported in official data; illegal fishing, where illegal catches in the North Western region alone can represent between 10% and 20% of all the values lost to illegal fishing globally [43]; marginalization of socio-economically vital sectors such as artisanal and subsistence fishing sectors, resulting in increased poverty rates within African coastal communities [28,29,81]; increased migrations towards the coast, in part as a result of climate change [95], and associated conflicts between coastal communities (migrant and non-migrant fishers) [17];

and increased sectoral conflicts between industrial (often foreign) fleets, and small-scale fishers, which can result in increased accidents at sea, reduced fishing opportunities for communities heavily reliant on fish for their food and livelihoods, again resulting in increased poverty, and the emergence of piracy as a direct consequence of these conflicts over space and fish stocks [104]. In turn, fish stocks have been over-exploited, particularly in the 1970s and 1980s when increasing catches by foreign fleets were barely reported [19,2,23,8].

This paper seeks to contribute to efforts towards a more comprehensive picture of African fisheries, including linkages between fisheries and different ocean issues, using available research and databases. The following sections summarize the state of African fisheries with regards to both their exploitation patterns and the policy opportunities and challenges they face, and discuss these patterns by region and coastal country.

2. Patterns of exploitation

Despite regional differences [19], some major trends for African fisheries in general can be revealed by analyzing fisheries catch data. Data extracted from the *Sea Around Us* database [86] show that overall catches increased from 2.1 million t in 1950 to 16.7 million t in 1988, and then decreased to 12.4 million t in 2010. The artisanal sector, whose landed value reached \$4 billion US in 2010, has been in decline

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¹ (<http://www.fao.org/docrep/x0262e/x0262e09.html> [Accessed on 23/08/2017]).

since 2004 along with increasing catches of the industrial sector, despite an increasing fishing effort. Subsistence sectors, consumption driven fishing activities conducted in many cases almost exclusively by women [16,19,21,58], caught 411,000 t in 2010. Overall, catches by this sector increased over time. However, with the over-exploitation of fish stocks, costs of fishing increased [25], translating into a shift from subsistence to artisanal fishing [16]. The recreational sector, whose fishing expenditure is valued at 7 times its value on a market, using the newly developed Recreational to Commercial Ratio (RCR) [11], constitutes 0.4% of the fishery in catch amount and 4% in economic value (expenditure), and is mainly concentrated in Morocco and the Western Indian Ocean's coast of South Africa. This value is equivalent to the amount paid by for e.g., the Chinese for obtaining access to fishing grounds of 22 West African countries [24]. Unsustainable practices such as discarding are responsible for around 20% of catch losses [19].

2.1. The Mediterranean Sea region

Regional differences reflect varying cultures, ecologies and patterns of exploitation. In the Mediterranean Sea where continental shelves are usually narrow and exclusive economic zones (EEZs) very small, there is little room for the development of industrial fisheries [15,22,56,70,77]. On the other hand, the closeness of EEZs and the sharing of many fish stocks of the Mediterranean make it necessary to develop joint management systems across the border [106,107,80]. Regional management efforts, governed by the General Commission for the Fisheries in the Mediterranean (GCFM), concentrate on banning destructive fishing gear such as driftnets, dynamite and poison, while national initiatives such as marine protected areas remain scarce with only 5% of the continental shelf protected (calculated based on the MPA coverage from the Global Database of Protected Areas [68] and the EEZs for 2017). Over 280 taxonomic groups are exploited in the Mediterranean coast of Africa, with, however, a clear domination of small pelagic species such as sardines (*Sardina pilchardus*), sardinellas (*Sardinella* spp.) and anchovies (*Engraulis encrasicolus*) (37%) [www.seaaroundus.org]. Catch rate declines [22] indicate unsustainable levels of fishing. Indeed, of the 14 most targeted fish stocks, 10 are fully or overfished, including stocks of sardines, anchovies and other small pelagics [48]. An in-depth look into various fish stock status indicate a severe level of depletion throughout the Mediterranean region (Fig. 1). Increasing fishing subsidies and the effects of the Arab spring have transpired in fisheries as illegal fishing increased, particularly by boats from the EU and Korea targeting tunas and billfishes, [22].

2.2. The Canary Current Large Marine Ecosystem

The Canary Current region comprises North West Africa, experiences strong seasonal upwellings driving an exceptionally high productivity and is home to West Africa's largest Marine Protected Area –The Banc D'Arguin National Park. Over 3300 industrial vessels (20% foreign) and 54,000 artisanal and subsistence pirogues catch over 6.4 million t of fish per year [20,27] generating a landed value of \$10.6 billion US [25]. Artisanal fishing is conducted for commercial purposes as a professional job (a “métier”), while subsistence fishing serves the primary household needs and is conducted mainly for personal consumption. Subsistence fishing usually requires low investment in boats and fishing gear and is mainly conducted from land. Catches peaked in the late 1990s and have been declining since then despite or because of an increase in the fishing effort. However, as this region is also targeted by foreign fleets operating legally (under agreement) or illegally, at least 15 of the 18 important coastal demersal stocks and pelagic resources (e.g. sardinellas *Sardinella* spp., horse mackerel *Trachurus trachurus*, chub mackerel *Scomber colias*, anchovy *Engraulis encrasicolus*, and bonga shad *Ethmalosa fimbriata*) are fully or over-exploited [34]. This raises serious concerns about food security and the sustainability of fishing access agreements with foreign countries [2,24,53,63,67,73].

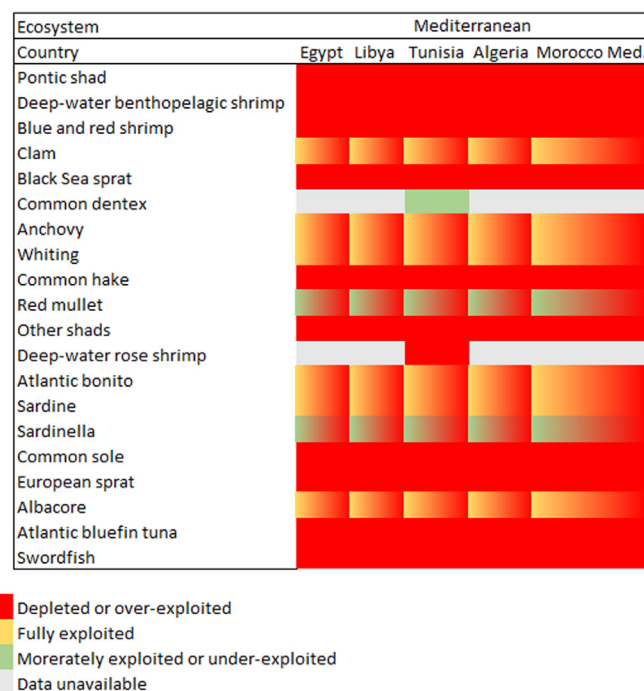


Fig. 1. Stock status in the Mediterranean Sea. Adapted from FAO [49] and <http://firms.fao.org/fi/website/FIRMSSearchAllPanel.do> [Accessed on 08/09/2017].

Overall, most fish stocks in the region are either fully or over-exploited (Fig. 2). Despite the existence of the Sub-Regional Fisheries Commission (SRFC), pelagic fish stocks, which are highly migratory, are not managed jointly at a regional level, rather each country decides which management model to use in their own EEZ [34]. Most management initiatives are limited to reducing the fishing effort of both the industrial and artisanal sectors, with limited success [20,27,3]. This, along with under-reported catches, leaves no room for a surplus, and created a major competition between industrial and artisanal fleets [16]. In addition, fish distribution shifts induced by climate change [17,4,72,91] contributed to the emergence of a new kind of large pirogues (from 9 m in the 1970s to 30 m today) that fish within the waters of Senegal all the way to the coasts of Sierra Leone. These new pirogues now bring in ~50% of the artisanal catch landed in Senegal [16,31]. Increasing fishing range, and hence fuel usage has contributed to increasing fishing costs and deepening poverty among the over 143,000 artisanal fishers in the region with an average daily income of 13 US dollars [25].

2.3. The Guinea Current Large Marine Ecosystem

The same pattern described above is observed in the Guinea Current LME (GCLME) with an even higher poverty rate within fishing communities and a daily income of ~\$6 US dollars on average for over 610,000 artisanal fishers [25]. The GCLME is characterized by a relatively wide continental shelf with low lying coastal topography and a large number of estuarine systems with strong river inflows [112]. The GCLME region exhibits one of the highest population growth rates in the world, which puts a severe strain on local fisheries, also heavily targeted by important foreign fleets [112]. Many of the countries therein have been affected by *coup d'états*, civil wars, and more recently epidemic outbreaks. This leaves the region highly exposed to illegal fishing, which in turn constrained the growth of small-scale fisheries, and partly drove the expansion of their geographic and time ranges [20]. This situation has contributed to increasing legal (and illegal) short fishing migrations by the Senegalese fleets towards the waters of



Fig. 2. Stock status in the Canary Current LME. Adapted from FAO [49] and <http://firms.fao.org/fi/website/FIRMSearchAllPanel.do> [Accessed on 08/09/2017].

other countries [23]. These migrations last a relatively short amount of time and should not be confused with the historical migrations of fishers in West Africa. In this kind of migrations, fishers operate in a host country where they usually do not land their catches, and are ultimately invisible in statistics. For example, the Ghanaian artisanal fleet operating illegally in Liberia generates 24% of the total illegal fishing loss, which is comparable to the illegal catches of Korea and China [23]. Of the 450 industrial vessels operating in the GCLME region, an estimated 60% are foreign and target medium sized demersal species whose landings add little to no value to African economies [24]. Marine protected areas in the region constitute 6% of the continental shelf [www.protectedplanet.net], with less than 1% classified as no-take and where monitoring efforts are low at most. Most assessed fish stocks are reported as fully or heavily overfished (Fig. 3) in the region [35], which contributes to increasing incursions by demersal trawlers into artisanal fishing areas to target the sensitive fish reproduction areas [13]. Main management recommendations consist of limiting or reducing fishing effort and catch. However, management successes remain limited as monitoring, control and surveillance are confronted with high corruption and low governance [64].

2.4. The Benguela Current Large Marine Ecosystem

The Benguela Current LME (BCLME) is one of the most productive ocean ecosystems in the world in terms of biomass production and fishery resources due to the upwelling of cold, nutrient rich water [33,36]. The BCLME which comprises Angola, Namibia and the western coast of South Africa experienced severe over-exploitation by foreign fleets [109,39], as illustrated by the collapse of several fish stocks during the 1960s and 1970s [62]. These patterns are notably observed in Namibia, where the uncontrolled fishing activity before Namibia's independence in 1990 led to the collapse of several fish stocks [51]. After independence, Namibia implemented a policy of rebuilding stocks to their "full potential" using various management approaches such as increased monitoring, total allowable catch adjustment, effort limitations and seasonal or spatial fishery closures [51]. As a result, fisheries have become the second largest foreign currency earner in the country [26], while the main fished stocks are rebuilding. Striking differences of culture exist in the BCLME [101]. Namibia, which generates most of its fishery revenues from the industrial sector, has only but little under-reporting [26]. All fishing fleets have to land their catches in Namibia, at the two landing ports in Walvis Bay and Lüderitz, to allow for added value [105]. As a result, industrial fishing contributes \$354 million US to the landed value, which increases to \$1.7 billion US in terms of

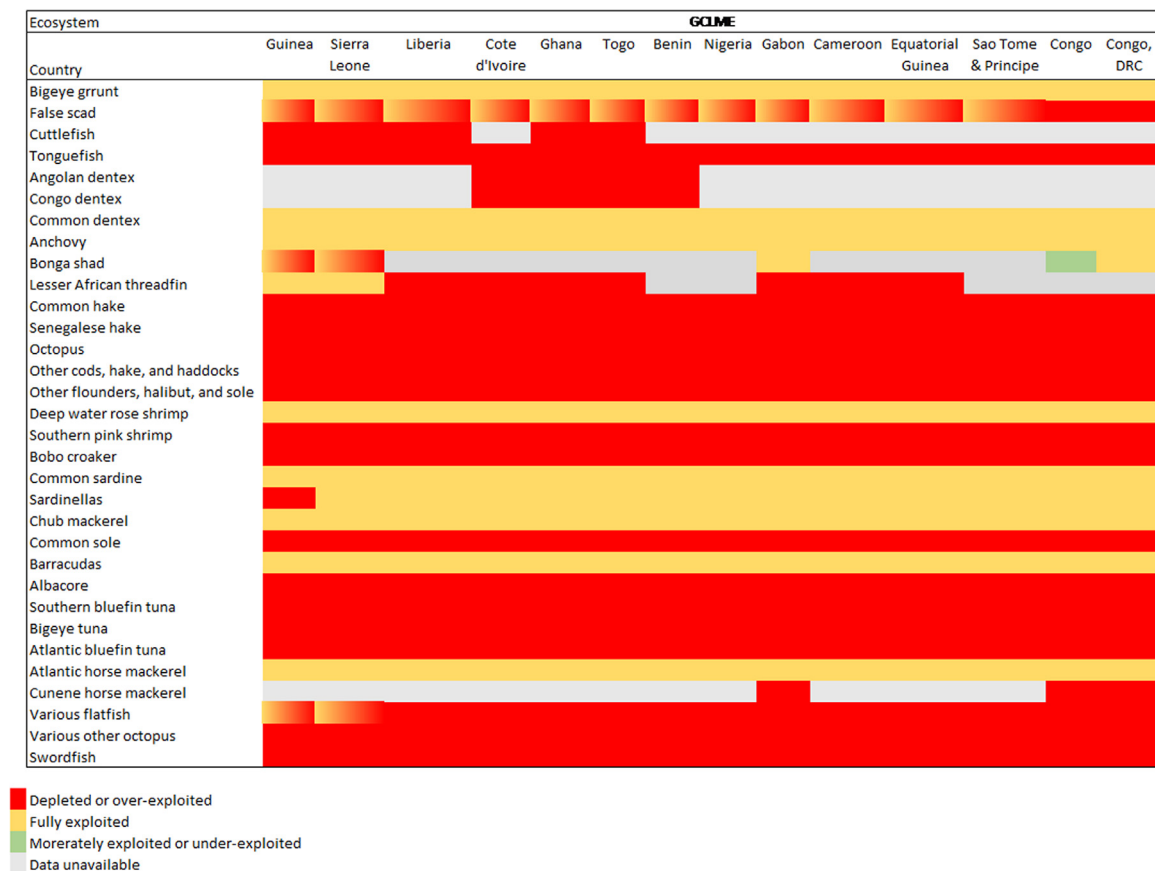


Fig. 3. Stock status in the Guinea Current LME. Adapted from FAO [49] and <http://firms.fao.org/fi/website/FIRMSSearchAllPanel.do> [Accessed on 08/09/2017].

economic impact considering the economic multiplier for the country [26,45]. Angola's domestic fisheries (457,000 t in 2010) experienced heavy competition by foreign legal and illegal fleets (200,000 t in 2010), which include mainly Chinese bottom trawlers and pair trawlers [14], while in South Africa, traditional fishers remain excluded from the new fisheries framework [101]. Overall, catches from the BCLME have declined drastically after their peak of 5.3 million t in 1967 due to heavy and unsustainable exploitation by “foreign” fleets (including those of South Africa in its former colony Namibia), resulting in the collapse of Pacific sardines (*Sardinops sagax*) and Cape hakes (*Merluccius* spp.) [19]. In addition, most remaining fish stocks are either fully or over-exploited (Fig. 4).

2.5. Agulhas Current Large Marine Ecosystem

Fisheries catches in the Agulhas Current LME peaked at 1.3 million t in the late 1960s and have been declining since then to 700,000 t in 2010, of which 52% are caught by industrial, 22% by artisanal, 18% by subsistence fishers, and less than 1% by recreational fishers. Most of the catch is taken by coastal countries, i.e. South Africa (the largest fishing country of Africa, 50%), Mozambique and Madagascar (20% each) [75]. Foreign non-African catches represent 5% of the total catch. Country specific differences exist in the region, particularly with regards to fishing sectors. Some 700,000 recreational fishers in South Africa target over 200 species, catching 5200 t of fish in 2010 [75]. This catch generated the equivalent of \$79 million US in expenditure, using the RCR [11]. Extensive recreational fishing is responsible for the decline of various fish stocks [75]. The other particularity of South Africa fisheries is that the reporting system is much more effective on the Atlantic coast (7% unreported) than the Western Indian Ocean coast (77.3% unreported) [10,75]. In comparison, Mozambique has shown significant improvement in reporting practices, with only 5%

unreported catches in 2010 compared to 500% during the mid-1980s catch peak at the height of the civil war [75]. Despite improved reporting in Madagascar, over-exploitation and illegal fishing fleets that catch over 70,000 t per year threaten the source of livelihoods for about 120,000 Malagasy small-scale fishers (Le [74]), a trend that is similar to those of their counterparts in West Africa [25]. Similarly, small-scale artisanal and subsistence fisheries also prevail in Comoros with 80% of the catch, all noting a major decline in fish abundance and size [75]. The trend shifts quickly in the neighboring (French) islands (Mozambique Channel Islands, Mayotte, Glorieuse Island) as investment-intensive industrial [foreign] fishing for large pelagic species is prevalent. This trend repeats itself in the French La Reunion, where small-scale catches represent less than 20% of the total catch, and in Mauritius (30% small-scale) and in the Seychelles (7%) where in spite of declines in fish biomass and size, no substantial reduction in the fishing effort was noted [75]. Stock status trends vary widely in this region (Fig. 5) from under-exploited for some cephalopods to depleted for some shrimp and tuna species.

2.6. The Somali Coastal Current Large Marine Ecosystem and the Red Sea

Catches within the Somali Coastal Current, where some 63,000 small-scale fishers operate, have peaked at 300,000 t in 2003. Over half of the total catch in the Somali Current LME was caught by foreign fleets. Foreign fleets compete with a small-scale sector whose catches reached 160,000 t (73% of the total) in 2010 [55]. This trend is particularly pronounced in Somalia, where despite a very small number of fishers (estimated between 4500 and 9500), the high frustration caused by this competition – among other factors such as state failure and waste dumping – arguably led to piracy [104,55,59,92]. In Somalia, territorial and fragmentation as well as breakdown between disputed central authorities and semi-autonomous regions such as Puntland have

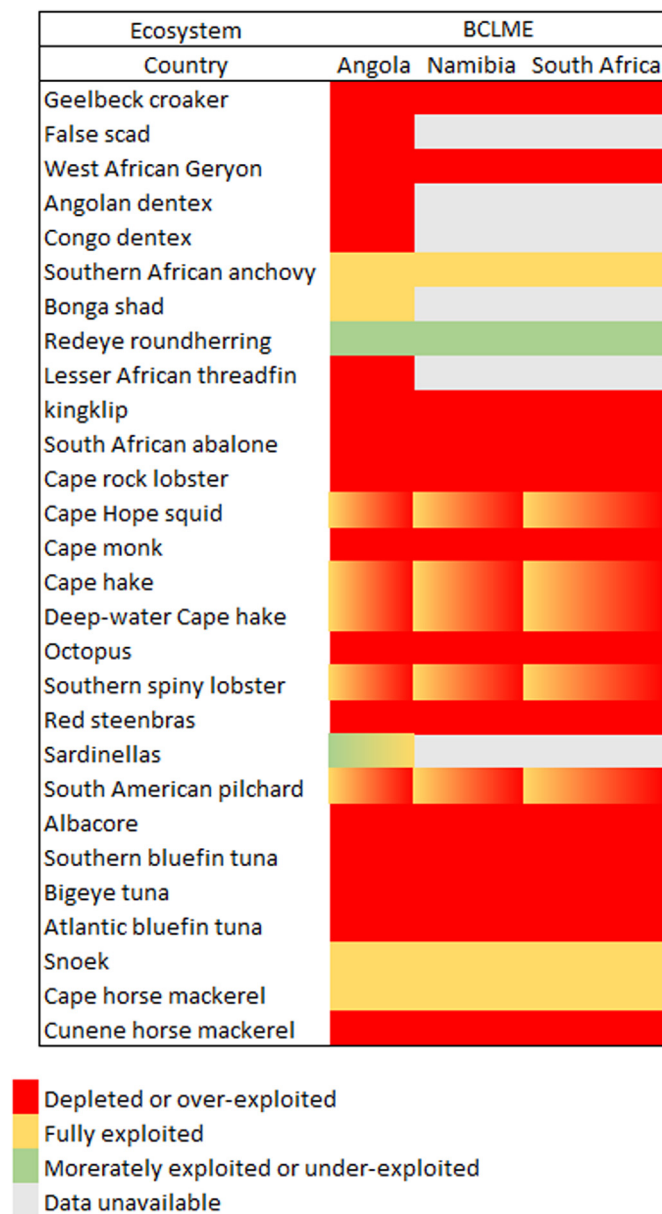


Fig. 4. Stock status in the Benguela Current LME. Adapted from FAO [49] and <http://firms.fao.org/fi/website/FIRMSSearchAllPanel.do> [Accessed on 08/09/2017].

contributed to increasing the unregulated fishing effort on local stocks [59]. The government of Puntland and China signed a fishing agreement worth \$10 million US, but the agreement is illegal under Somali laws and regulations.² As a result of extensive fishing, at least 8 major fish stocks are fished at unsustainable levels [55], and 13 range from fully fished to depleted (Fig. 5). In Kenya, the decline of small-scale fisheries catches is associated with the recreational and tourist fishing sectors [75], an irony in a country where marine protected areas constitute 10% of the inshore fishing area.

In the Red Sea (Eritrea, Sudan, Egypt and Djibouti), fisheries catches have declined from their peak of 60,000 t in 2000 to less than 40,000 t in 2010 [111]. Information on fisheries trends and stock status in this LME's countries are scarce. However, the decline in fisheries catches in the region is an indicator of over-exploitation as catches of anchovies

² (<https://www.brookings.edu/blog/africa-in-focus/2017/04/12/figures-of-the-week-piracy-and-illegal-fishing-in-somalia/> [Accessed on 11/09/2017]).



Fig. 5. Stock status in the Agulhas Current LME. Adapted from FAO [49] and <http://firms.fao.org/fi/website/FIRMSSearchAllPanel.do> [Accessed on 08/09/2017].

and herring have collapsed in the early 1980s, likely due to fishing pressure [111]. It is evident that the status and potential of fisheries varies between countries. Indeed, according to official figures, and despite a clear lack of information (Fig. 6), Eritrean fisheries, which employ over 3270 fishers, are believed to be exploited under their potential [7]. In Sudan, where 1938 artisanal fishers operate, the fishing sector is plagued with poverty [57], and yet remains one of the major drivers of coastal food security. In Djibouti, where industrial fisheries are not authorized, the EEZ is exclusively reserved for 270 artisanal fishers who are believed to exploit the fisheries therein significantly under their Maximum Sustainable Yield [37,42,92]. In Egypt's Red Sea, over 17,900 fishers operate, onboard over 1860 artisanal and industrial vessels (mainly trawlers and longliners) [92,98] (Fig. 7).



Fig. 6. Stock status in the Somali Current LME. Adapted from FAO [49] and <http://firms.fao.org/fi/website/FIRMSSearchAllPanel.do> [Accessed on 08/09/2017].

2.7. Taxonomic resolution

A total of 643 taxonomic groups were identified and caught by the different sectors operating throughout Africa, with similar trends of over exploitation in the various ecosystems being generally observed. In the Mediterranean, and the CCLME, domestic fisheries catch mainly small and medium sized pelagic fishes (over 50% of the domestic catch) while foreign fleets catch mostly medium sized demersals in the CCLME and large pelagics in the Mediterranean. Medium sized demersals (sea catfishes, drums and croakers among others), medium sized pelagics (bonga shad) caught mainly by small-scale fisheries, and madeiran sardinella (*Sardinella maderensis*) and small-pelagics (European anchovy *Engraulis encrasicolus*, and sardinellas *Sardinella* spp.) dominate the

domestic fisheries of the GCLME, while foreign fleets catch mainly medium sized demersals and cephalopods. Three major groups are caught within the BCLME consisting of Cape horse mackerel (*Trachurus capensis*), Cape hake (*Merluccius capensis*), and, to a much lower extent, Pacific sardines, since the collapse of the stock in the late 1960s [109]. Similarly, in the Agulhas Current, catches consist mainly of Pacific sardine, Cape hake and southern African anchovies (*Engraulis capensis*). The diversity in catches is much lower in the Somali coastal Current and the Western coast of Somalia with only 180 taxonomic groups being caught, mainly medium and small sized reef associated fishes, medium sized demersals and large pelagic fish species. There is a significant overlap between the taxa caught by Somali fishers and those targeted by the foreign fleets operating in Somalia, which may explain the

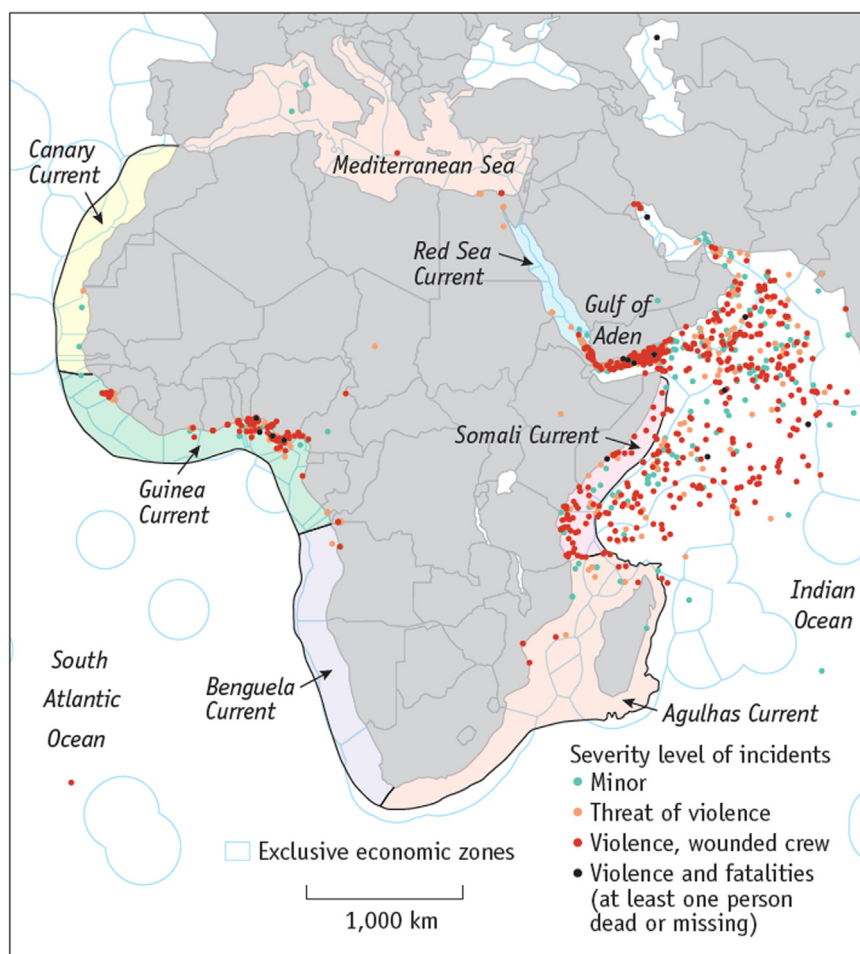


Fig. 7. Distribution of acts of piracy and armed robbery in the oceans around the African continent.

conflict which later led to the development of piracy in the region [104]. In the Red Sea, after the collapse of anchovy catches, jacks and pompanos and scads make up 40% of the 116 taxa caught.

3. Maritime and coastal insecurity patterns

Africa is among the most conflict-affected regions, with protracted civil wars, recurring coup d'états, and insecurity at sea [18,46,65]. Three main security dimensions are relevant for African fisheries, besides food security (see [30]): IUU fishing during acute periods of political instability; fisheries and maritime insecurity, including piracy, 'fish wars', human trafficking; and the human security dimension of climate change for coastal fisheries and populations. Many of these dimensions relate to each other with for example IUU relating to fisheries scarcity, fishing conflicts and piracy [94]. All six fisheries regions have been affected by conflicts and insecurity, though to various extent and mostly in the 1980s for Southern Africa (BCLME and ACLME), 1990s and 2000s for Western Africa (GCLME) and Eastern Africa (SCLME), and 2010s for North-Western Africa (CCLME) and the Mediterranean Sea (see Table 1).

3.1. Conflicts and social unrest

3.1.1. Civil wars and their impacts on fisheries

Civil wars, as measured through battle deaths, tend to have an immediate negative impact on reported catch levels [61], and positive impacts on catch levels when conflicts drive populations towards the coast, or when armed conflicts result in opportunistic fishing by foreign and neighboring countries' fishing fleets [18], a frequent collapse of

enforcement, and corruption by local authorities. A detailed study of Sierra Leone using figures from reconstructed fisheries and disaggregating between types of fisheries do point to a decline of domestic fishing, dissolution of the domestic industrial fishing fleet and displacement of traditional fishers, but also to an increase in subsistence harvesting and most importantly in illegal fishing by foreign fleets [99]. Countries with fisheries most affected by armed conflicts in the 1980s included Angola, Mozambique and Namibia, which saw civil wars and debilitated governance capacity facilitating IUU activities by foreign fleets [105,14,26]. A similar pattern affected Somalia from the 1990s onwards, especially given the absence of a national government leaving only ad hoc agreements being drawn by some foreign fishers with local warlords when their vessels were at risk of being attacked. In the Mediterranean, war-related IUU mostly affected Libya, with foreign fleets notably targeting Bluefin tuna [60]. In other cases, civil unrest led to the displacement of the fishing effort, such was the case of the Ghanaian artisanal fleet operating from Sierra Leone and Liberia as home ports as Ghanaian fishers left [5]. Eventually, the displacement of the fishing effort and the expansion of fishing grounds lead to the onset of a new generation of conflicts, directly linked to fisheries.

3.1.2. Conflicts over fisheries

Conflicts over coastal African fisheries have mostly been the result of competition between industrial and small-scale fishers, and to a lesser extent competition among small-scale fishers as well as clashes between industrial fleets, enforcement agencies, and conservation groups [100,50]. Conflicts have been reported in the Mediterranean over high-value species, such as bluefin tuna ([114]; Johnston, 2016), in the Gulf of Guinea over the activities of foreign fleets [87] and

Table 1

Relative level of concern over major fisheries-related security dimensions. Data extracted from the Armed Conflict Location & Event Data Project (www.acleddata.com).

Region	Mediterranean	Canary C.	Guinea C.	Benguela C.	Agulhas C.	Somali C.
IUU during conflicts	Medium	Medium	High	High	Medium	High
Fish wars	High	Medium	High	Medium	Medium	High
Piracy	Medium	Low	High	Low	Medium	High
Human trafficking	High	Medium	Low	Low	Low	Medium
Migration to coast	Medium	High	High	Medium	Medium	High
Climate exposure	Medium	Low	High	Low	Medium	Medium

between small-scale fishers and the oil industry [1,85], as well as militarized responses to some small-scale fishing activities in South Africa [83]. There has been, however, much fewer international fisheries disputes within African EEZ compared to other regions such as Asia, North America and Europe over the past forty years [102], in part the result of the more recent presence of distant fleets and lower levels of enforcement resulting from limited capacity and easier access for foreign vessels to obtain licences. Many conflicts, in turn, relate to foreign trawlers operating within areas reserved for small-scale fishers, outcompeting them and damaging their gear [44].

3.2. The rise of modern-day piracy

Piracy has so far mostly affected waters around the Horn of Africa (SCLME) and the Gulf of Guinea (GCLME). In Somalia, confrontations with illegal foreign fishers and protection rackets escalated into full-fledged piracy after 2006, with attacks then targeting all types of civilian vessels and generating an estimated \$ 350 million in ransom payments, before foreign navies and other measures curbed down attacks in 2012 [104,113]. Chronic political instability, widespread corruption and low-level insurgency in the Niger Delta since the late-1990s have sustained piracy in Nigerian and surrounding waters, with mixed effects on fishing efforts and catch levels as offshore racketeering and kidnapping deters some fishing vessels. Like in Somalia, but with the added dimension of grievances against oil exploitation, some Nigerian pirates justified piracy as a reaction to illegal fishing by foreign fleets [90]. Libyan militias acting as coast guards have also intervened against foreign fishers, given rise to reports of acts of piracy. Foreign navies have been increasingly active in patrolling the most affected African maritime spaces, while some foreign fishing fleets have hired private security [88,89]. Civil society organizations have sent boats to monitor and denounce illegal fishing or help migrants at sea. Not all national authorities have welcomed these initiatives, with the Nigerian federal government forbidding armed private security and refusing foreign military interventions to protect its sovereignty and monopoly on legitimate violence. Libyan coast guards have threatened boats from civil society organizations, accusing them of enticing and facilitating illegal migration.

The presence of foreign navies is generally resented by local fishers, who see these as protecting the activities of foreign fishing fleets [69]. Overall, the number of incidents has declined since 2001 for West Africa, and since 2012 for East Africa due to improved security measures notably through international cooperation on the East African side (Fig. 8). Greater security will result from improving local governance, reducing corruption, and improving livelihoods among coastal communities.

4. Illegal migrations and maritime migrant smuggling

Beyond the migration of fishers within African waters, which increased to levels generating resource use conflicts [31], migration from Africa to mainly Europe has become reflective of the economic

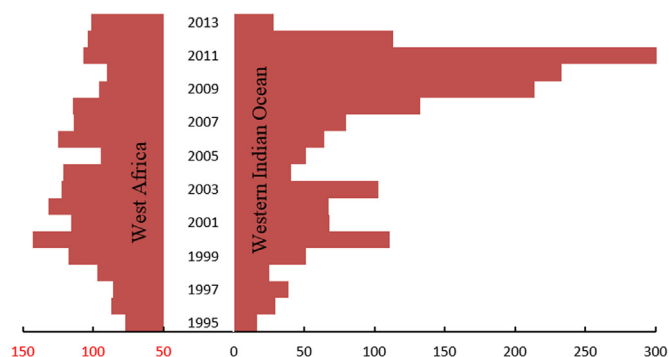


Fig. 8. Evolution of acts of piracy and armed robbery in the Western Indian Ocean and West Africa, between 1995 and 2013. [Note that Western Indian Ocean includes all the area comprised vertically between the Western Coast of India and the Eastern coast of Africa]. Data extracted from Leymarie et al. [76].

challenges faced by African youth. These trans-continental and often illegal migrations were recognized as being partly caused by fisheries collapse, amongst other economic and governance factors [71]. Although the link between fisheries collapse and illegal migrations has not been the subject of many scholarly articles, it remains widely recognized in the social sphere that fisheries collapse, and in other cases subsidization of e.g. small-scale vessels in Algeria, is a determinant factor of illegal migrations and migrant smuggling. Examples of this recognition include the documentary “Marayeur” in Senegal which discusses the link between fisheries collapse and migration towards Europe,³ and the movie “The Pirogue” when a fishing canoe (pirogue) is used to lead a group of migrants to Spain. Similar patterns where fishing boats are used to smuggle illegal migrants to Europe are observed in Algeria, as a result of a heavy subsidization by the government of the acquisition of fishing vessels [9]. The contribution of domestic fishing fleets to migrant smuggling and associated impacts on fisheries have not yet been well documented. While illegal migrants are generally transported with inflatable boats, fishing boats have been used for some of the 1.9 million detected illegal border crossings into EU territories via the Mediterranean Sea between January 2009 and June 2017, especially during the early years and since for more difficult crossings [52,6]. The smuggling of migrants has mostly taken place out of Libya to Lampedusa since 2011 (Central Mediterranean route), and to a much lesser extent from Morocco and Mauritania across the Strait of Gibraltar and to the Canaries (Western African and Western Mediterranean routes) (see Fig. 9). Migration is mostly seasonal, peaking during the summer months [52]. Studies on illegal migrations and migrant smuggling relating these issues to fisheries, or rather fisheries collapse remain scarce, but the evidence reviewed points to an increasing pattern and drivers which likely include resource scarcity, economic struggle, and heavy subsidies directed towards the

³ <http://www.infomigrants.net/en/post/9622/mareyeurs-senegal-s-fisheries-crisis-drives-migration> [Accessed on 02/12/2018].

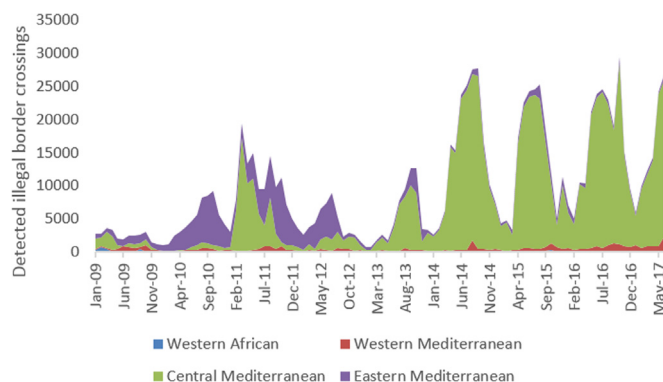


Fig. 9. Number of detected illegal border sea-borne crossings to Europe from Africa. Data extracted from Frontex [52].

acquisition and operation of fishing boats.

5. Climate change, fisheries and coastal flooding

Several African coastal countries are likely to be affected by climate change in terms of migrations and fisheries. Recurring droughts in the interior constitutes a push factor drawing people to the coast. Yet some coastal areas are also vulnerable to climate-change induced events, such as flooding and erosion, with Mediterranean Sea and the Guinea CLME having the most people in Low Elevation Coastal Zones (LECZ), followed by Eastern Africa (ACLME and SCLME) [82]. Globally, the African region is on average the second most vulnerable to climate change in terms of fisheries, after Oceania, with the most vulnerable areas being in Eastern Africa and the Gulf of Guinea [32]. Given these two distributions, the largest number of people made insecure by climate-related displacement and changes in fisheries are in the GCLME and ACLME zones.

Linkages between security issues and climate change are rather unclear [102], yet climate change is becoming an matter of increasing concern for maritime security [54], notably as fish moves towards areas with more fitting ocean conditions [93]. In addition, resource scarcity and environmental change due to climate change may influence some patterns of violence, crime, smuggling, and terrorism by sub-state groups and networks [66]. As these threats are often transnational, they call for the involvement of both regional and international powers and initiatives to assist in addressing them, such as the cooperation efforts to curb piracy in the Western Indian Ocean [38].

In many parts of Africa, climate change can increase the vulnerability of coastal communities to resource scarcity [94], which in turn can have drastic repercussions on the occurrence of maritime criminality [78]. These intertwined processes should be, and increasingly are, part of ocean governance processes in the region. Indeed, how the issues discussed above are dealt with is reflective of various governance models, and depending on the economic strategy at hand, focusing on food security or increased export strategy, and participation in international initiatives. As discussed below, governance patterns, represent a key factor in understanding and addressing maritime issues related to fisheries over-exploitation, climate change, and maritime security.

6. Governance patterns

6.1. Monitoring and surveillance patterns

Overall, in Africa, industrial fisheries are almost exclusively operated and controlled by foreign interests and their catches are barely recorded [24]. Monitoring efforts for the artisanal sector vary from good (based on comprehensive surveys) to nonexistent. Subsistence and recreational fisheries are not monitored and in many cases, are simply assumed to be marginal. Finally, discards are assessed occasionally if at

all, whenever industrial vessels carry observers onboard. Illegal fishing and intense under-reporting (52%) of the total catch are increased by the lack of governance, high corruption, and little transparency on fishing agreements [24]. However, positive patterns can be observed through community-based management successes, particularly through an increasing network of Marine Protected Areas which covers today 22% of Africa's inshore areas, and initiatives combating illegal fishing such as Fish-I Africa, and Oceans Beyond Piracy. Among other cases of enforcement efforts, three small African nations were behind the arrest of 3 of the internationally wanted *Bandit-Six*, a black listed fleet. Similarly, community surveillance along with Pan-African collaborations resulted in the arrest of illegal fishing vessels in Liberia (working with Eastern African countries) and the successful termination of wrongful fishing agreements in Senegal. The Park National du *Banc d'Arguin* has shown an increase in shark and fish populations, the seasonal closure in *Ngaparou* in Senegal resulted in higher lobster catches and size, while community-based management of MPAs in Kenya and Senegal were reported as successful in increasing fish size and abundance [79,97]. The Total Allowable Catch (TAC) system in the BCLME has contributed to rebuilding hake and mackerel fish stocks [26]. The latter measures (marine protection and output controls) are typical policy measures intended for the conservation of fish stocks, and have been used amongst many other policy initiatives.

6.2. Fisheries policy patterns

There is much diversity in political histories, fishing traditions, and management systems within Africa. Regional organizations (Table 2) exist that serve as umbrellas for regional policy, while national authorities are mainly responsible for domestic regulations and upholding international agreements they are part of. Countries are also accountable for the activities of the fleets that are flagged to their country [103]. However, the particularity of African countries that have a high dependence upon fishing, large foreign fishing presence, and often low governance power, has contributed to limited successes with regards to effective policy that aligns with international sustainability objectives such as the Sustainable Development Goals of the United Nations, regional and national priorities, including, food security, employment, and socio-economic sustainability of fisheries and the communities that depend on them, and development assistance. African fisheries are commonly regulated through a combination of Fisheries Acts, Ministerial Decrees, and Executive Orders that dictate geographic, temporal, biological, and fishing gear restrictions, along with other input/output management regulations.

1. Fisheries Acts: Fisheries Acts are rarely updated, which, in the context of rapidly evolving fisheries, can constrain any policy intervention aimed at, for e.g., limiting fishing effort, increasing illegal fishing sanctions, updating fishing seasons when new information of fish species reproduction patterns is available, or the geographic openings and closures of fisheries.
2. Ministerial decrees: Ministerial decrees are one alternative that allows countries to overcome the burden of reviewing their Fisheries Act, which may take long periods of time before being legislated. However, institutional instability can be very limiting when it comes to ministerial decrees, and as governments shift (often senior officials relieved from their functions), priorities and agendas can change. Senegal has seen 5 Fisheries Ministers in less than 5 years under the same presidential mandate. In addition, corruption can be a strong incentive behind ministerial decrees or their absence [108,115]. As an example, when Guinea received its first warning of a red card from the European Union, it was revealed that the then Fisheries Minister (2012) owned shares of a joint venture fishing company whose vessels were often fishing illegally in Sierra Leone and finding refuge in Guinea [47].
3. Testing policy measures prior to legislation: Often, policy measures

Table 2
International and Regional Fisheries Organizations covering African maritime waters.

Name	Aim	Member countries
Atlantic side		
International Commission for the Conservation of Atlantic Tunas (ICCAT)	Manage highly migratory species	Mediterranean and Atlantic countries
Ministerial Conference on Fisheries Cooperation among African States Bordering the Atlantic (COMHAFAT-ATLAFCO)	Cooperation among member states to promote conservation and management of fish stocks	Atlantic countries (exception: South Africa)
Fishery Committee for the Eastern Central Atlantic (CECAF)	Promote sustainable development of fisheries and fish stocks	Angola, Benin, Cameroon, Cabo Verde, Dem. Rep. of the Congo, Congo, Côte d'Ivoire, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mauritania, Morocco, Nigeria, Sao Tome and Principe, Senegal, Sierra Leone, Togo
Sub-Regional Fisheries Commission (SRFC)	Harmonize national policies of member countries towards the conservation and sustainable management of fisheries	Mauritania, Senegal, The Gambia, Cape Verde, Guinea Bissau, Sierra Leone, Guinea
Fishery Committee of the West Central Gulf of Guinea (FCWC)	Cooperation among member states to promote conservation and management of fish stocks	Liberia, Cote d'Ivoire, Ghana, Togo, Benin, Nigeria
Regional Commission of Fisheries of Gulf of Guinea (COREP)	Harmonize fisheries policies and regulations of member states while ensuring the sustainable exploitation and conservation of fish stocks	Cameroon, Congo, Dem. Rep. of the Congo, Gabon, Sao Tome and Principe
Indian Ocean side		
Indian Ocean Tuna Commission (IOTC)	Manage highly migratory species	Eritrea, Comoros, Guinea, Madagascar
Southwest Indian Ocean Fisheries Commission (SWIOFC)	Manage fish stocks by geographic area. Sustainable use of aquatic resources within area.	Comoros, Kenya, Madagascar, Maldives, Mauritius, Mozambique, Seychelles, Somalia, South Africa, United Rep. of Tanzania
The Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA)	conservation of the coastal and marine environments	Djibouti, Egypt, Somalia, and Sudan
General Fisheries Commission of the Mediterranean	Manage fish stocks by geographic area	Algeria, Egypt, Libya, Morocco, Tunisia

are tested before being legislated and adopted. In Senegal for example, as the new Fisheries Act was being developed, a new policy aiming at drastically increasing fines against illegal fishing was immediately preceded by a historical move of sanctioning the Russian fishing vessel Oleg Naydenov with over \$ 414,000 US for fishing illegally within Senegalese waters (<http://www.bbc.com/news/world-africa-25621864> [Accessed on 23/08/2017]). In the Gambia, all industrial fishing licences were suspended in a move to limit the lack of transparency around industrial (and particularly foreign) fishing activities, however, as elections followed, no formal policy was adopted as the Fisheries Act is yet to be revised. In Guinea, the drastic revision of the Fisheries Act in 2015 has led the European Union to relieve the sanctions (red card) against Guinea, however, the degree of implementation is yet to be determined. In Eastern Africa, Somalia has focused its policy efforts on prioritizing access for local fishermen while ensuring security at sea and reducing piracy by actively engaging with regional and international organizations. Today, Somalia has the largest artisanal fishing area in Africa, i.e., the area that is exclusively reserved for artisanal fishers and strictly prohibited to industrial fishers [12]. These areas exist all along the African coasts, with the exception of Namibia and the Democratic Republic of the Congo, and are between 3 and 24 miles offshore.

4. International policy agreements: International policy agreements and sanctions are another alternative that, when upholding countries accountable, can result in effective policy changes, i.e., actual implementation of effective policies. Examples of these agreements include the United Nations Agreement on Straddling and Highly Migratory Fish Stocks, the Code of Conduct for Responsible Fisheries, the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, the International Port State Measures Agreement, and others, with various binding and enforcement degrees. Whenever countries fail to withhold their responsibilities as a state, such as effectively combat against illegal fishing and related trans-national crimes, sanctions can be imposed against such nations, as done through the EU yellow and red carding system. Yellow cards serve as a warning,

while red cards bans exports of fish and fish products to the EU from the carded country. Comoros is the only country in Africa that has an ongoing red card (as of August 23rd, 2017), while Liberia and Sierra Leone have been slapped with yellow cards. Other African countries were previously yellow or red carded but have made significant improvements in their fisheries enforcement and legislation. These are Ghana, Guinea, and Togo (<https://www.fishwise.org/2017/05/24/status-of-iuu-nations-carded-by-european-commission/> [Accessed on 23/08/2017]).

5. Taskforces and International cooperation: Other regional and international measures exist such as the initiative Fish-I Africa, a task force that is effective in reducing the impacts of illegal fishing (member countries: Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Tanzania, and Somalia), and its counterpart in West Africa at the Fishery Committee of the West Central Gulf of Guinea. These kinds of initiatives, mainly driven by the non-governmental sector, fill important gaps with regards to regional initiatives and access to information on IUU fishing vessels. Finally, the Fisheries Transparency Initiative (FiTI) is increasingly attracting members in Africa and elsewhere, with Mauritania being one of the founding member countries. While the intent, and the regional agreements to e.g. allow for the right of pursuit amongst others exist [84], the implementation of many of these regional initiatives remains plagued with complex bureaucratic processes. Despite numerous national and regional policy and enforcement initiatives, illegal, unreported and unregulated fishing remains one of the main threats to African fisheries, and the communities benefiting from them. In addition to an important ecological footprint, illegal fishing has labor dimensions related to indirect effects such as the loss of livelihoods and income, but also direct implications on security as a whole. The emergence of piracy in Somalia is a good example of how illegal fishing can threaten national security in unexpected ways.

7. Conclusions

Similarities in patterns of exploitation exist across the different

regions of Africa. These consist of the over-exploitation pattern, the increase in the fishing effort in number, time and space, the adoption of new migration routes in Senegal and Ghana due to over-exploitation [2,8], climate change [17,72], and the emergence of piracy triggered by illegal fishing vessel incursions in East and West Africa, the very nature of some permissive institutional environments, and the inability of the state or the economy to provide employment in the fishing sector [40]. These patterns threaten the sustainability of fisheries in the region and limit the ability of countries to meet their food security and reduction of poverty objectives.

The over-exploited state of many African fish stocks calls for increased policy interventions, where opportunities are limited. Lack of appropriate fisheries data, or the use of inappropriate data, such as reported catch data instead of total catch data, and often outdated Maximum Sustainable Yield information, or erroneous data on reproductive cycles of fish species can significantly hinder management solutions. Three main policy recommendations emanate from this paper:

- Long term national policy interventions that are legislated through Fisheries Acts can be difficult to achieve given the uncommon changes in Fisheries Acts. Parallel efforts should focus on the international scene for long term policy changes, or create a culture by informally testing policy measures while working with decision makers;
- Short term policy interventions, despite institutional instability challenges, are key in creating a basis for longer term policy measures adoptions, hence, efforts should also focus on active conversation with existing stakeholders including the scientific community, governments, non-governmental organizations, communities, and fishers;
- As the example of The Gambia shows, drastic measures are possible such as suspending all industrial fishing activities until a better fishery monitoring system exists. However, these should be adopted and implemented while considering the risk to stakeholders, and fish stocks. The example of Senegal [16] shows that despite suspending fishing licences and banning foreign fishing vessels, in the absence of proper monitoring these vessels can keep fishing illegally and their footprint can become obsolete.
- Development assistance aimed at fisheries should focus on creating a sustainable monitoring framework that increases fines against illegal fishing but also against under-reporting of fisheries catches. Ultimately recovering surveillance costs through increased sanctions will help reduced dependence on foreign funding to sustain monitoring control and surveillance efforts.

The very existence of marginalized sectors of the population, mainly associated with small-scale fishing, calls for the necessity of political action on the support of new management measures that are more inclusive of fishing communities. In addition, development assistance focusing on policy should work hand in hand with communities to integrate all dimensions of traditional knowledge and management techniques.

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